National Aeronautics and Space Administration

NASA Headquarters Earth Science Division and Convective Processes Experiment 2022

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2022 Tropical Cyclone Operations and Research Forum

March 9, 2022

Acknowledgments

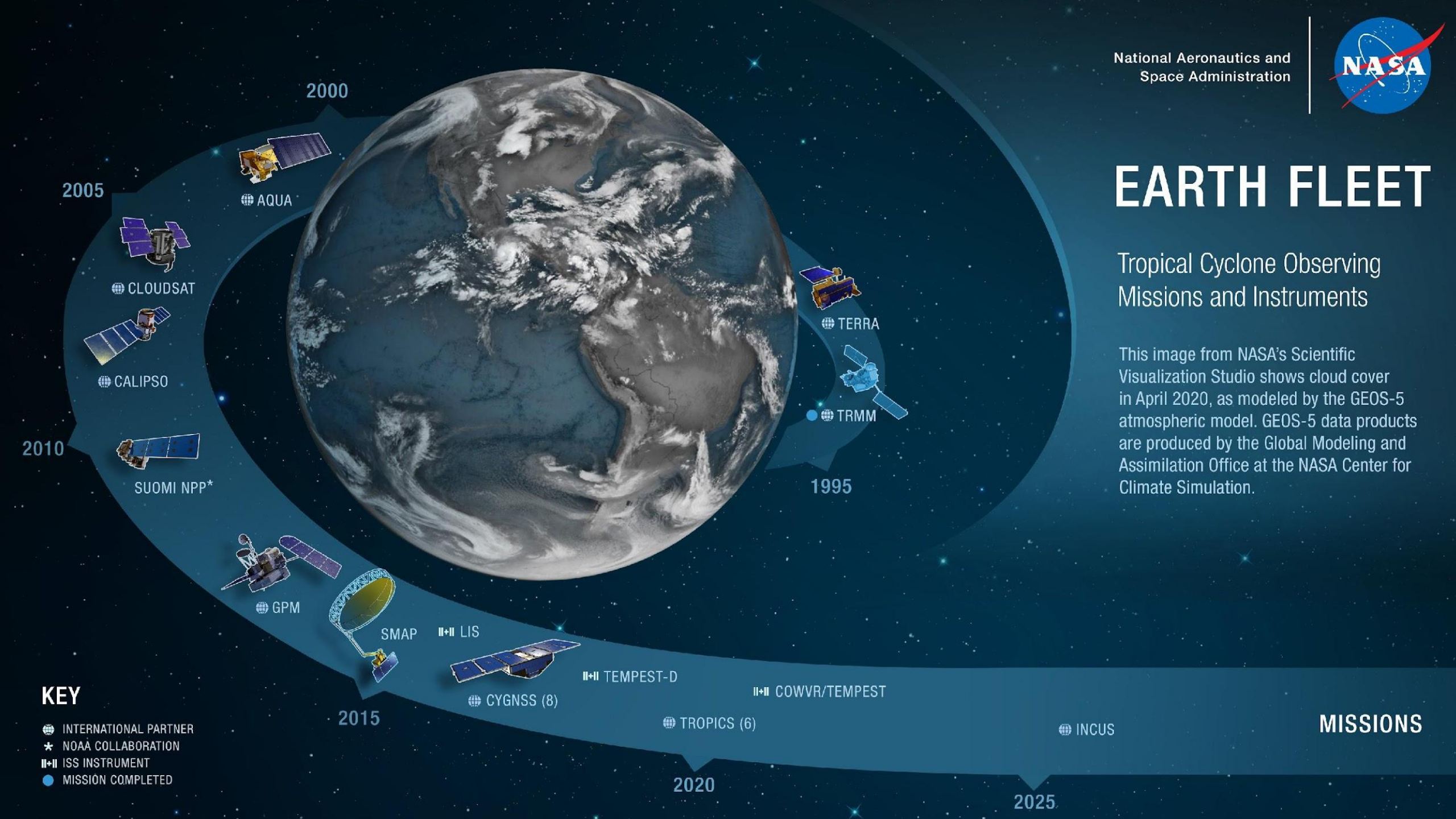
- NASA Headquarters
  - Jack Kaye, Associate Director for ESD Research & Analysis
  - Tsengdar Lee, Weather and Atmospheric Dynamics Focus Area Lead
  - Will McCarty, Weather and Atmospheric Dynamics Focus Area Program Manager Scientist
  - Bruce Tagg, Director of NASA Airborne Science Program

National Aeronautics and Space Administration

EARTH FLEET

Tropical Cyclone Observing Missions and Instruments

This image from NASA's Scientific Visualization Studio shows cloud cover in April 2020, as modeled by the GEOS-5 atmospheric model. GEOS-5 data products are produced by the Global Modeling and Assimilation Office at the NASA Center for Climate Simulation.



KEY

- INTERNATIONAL PARTNER
- ★ NOAA COLLABORATION
- ISS INSTRUMENT
- MISSION COMPLETED

What we do in the Weather and Atmospheric Dynamics Focus Area

Flight (including Data Systems)

- Develops, launches, and operates NASA's fleet of Earth-observing satellites, instruments, and aircraft (GPM, CYGNSS)
  Future Missions: TROPICS, INCUS, AOS, PBL
- Community Smallsat Data Acquisition
- Open Science & Open-Source Science

Interagency and International Interfaces

- ICAMS
- JCSDA
- NOAA, ONR, DOE (ARM)
- ECMWF, ESA, JAXA, CNES
- CEOS, CGMS, GEO

Earth Science Technology Office

- Develops and demonstrates technologies (software and hardware) for future satellite and airborne missions:
  - InVEST, IIP, AIST

WADFA

Research & Analysis

- Supports integrative research that advances knowledge of Earth system (6 focus areas)
- ROSES Research solicitations
- Modeling, Analysis, and Prediction (MAP) Program
- High-end Computing
- Field Campaigns: validation, process obs.

Core Facility Assets

- MSFC/SPoRT
- GSFC/GMAO and NCCS
- Instrument Assets at LaRC, JPL

Applied Sciences

- SPoRT is heavily leveraged by the ASP's Disasters Area
- Exploring collaboration with ASP's Food Security and Agriculture Area
- Disaster Rapid Response
- ROSES and Flight funded activities

Research & Analysis: Active ROSES Research Solicitations

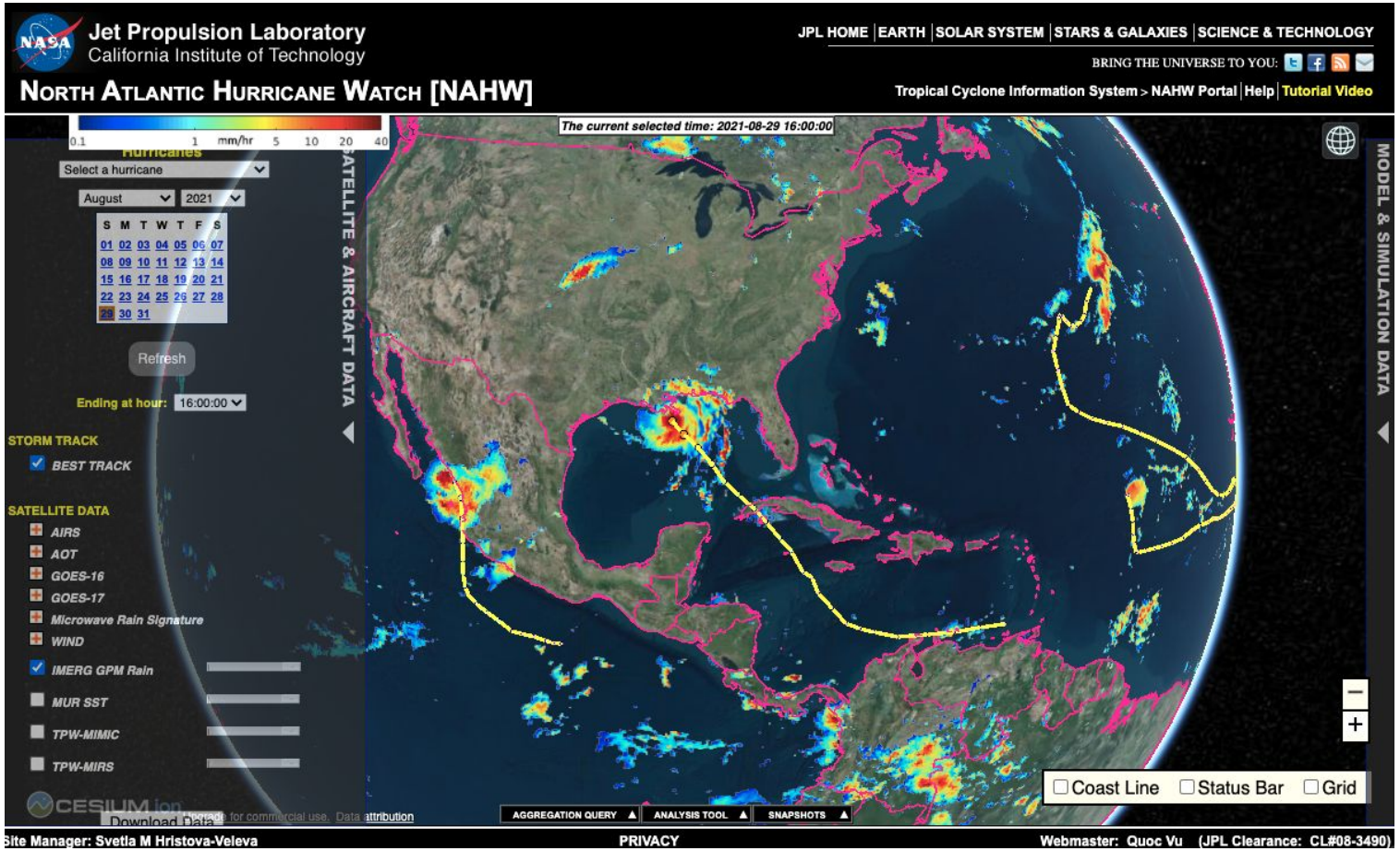
- Register for an NSPIRES account to receive updates: www.nspires.nasaprs.com (or Google “NASA NSPIRES”)

ROSES Year	Solicitation Short Title	# Yrs of $
2021	Precipitation Measurement Missions Science Team (selections were announced January 2022)	3
2021	Increasing Participation of Minority Serving Institutions in Earth Science Division Surface-Based Measurement Networks (due March 16, 2022)	3
2021	Subseasonal-to-Seasonal Hydrometeorological Prediction (Due March 10, 2022)	3
2022	Interdisciplinary Research in Earth Science (NOIs due: Oct 14, 2022; Proposals due: Nov 16, 2022) - Subelement 4: Environmental and Climate Justice using Earth Observations - Subelement 6: Ocean worlds: Research at the Interface	3
2022	Earth Science Research from Operational Geostationary Satellite Systems (Expected 2022)	3
2022	Weather and Atmospheric Dynamics (Expected 2022)	3
Annual	FINESST (Graduate Student funding; up to 3 years funding solicited every year)	3
Ongoing	Rapid Response and Novel Research in Earth Science	1

NASA Airborne Science Program

NASA Modeling

- Models codify our understanding of the Earth system
- Model predictions provide useful information for research, management, and policy-making purposes
- Modeling groups at NASA Goddard, Marshall, and JPL

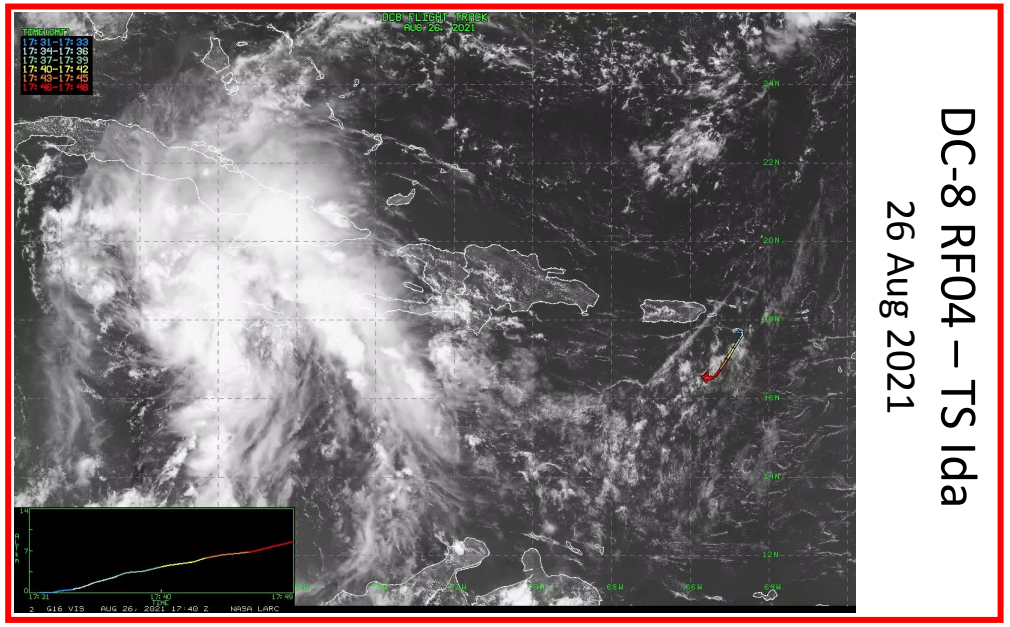


2021 Convective Processes Experiment – Aerosols and Winds (CPEX-AW)

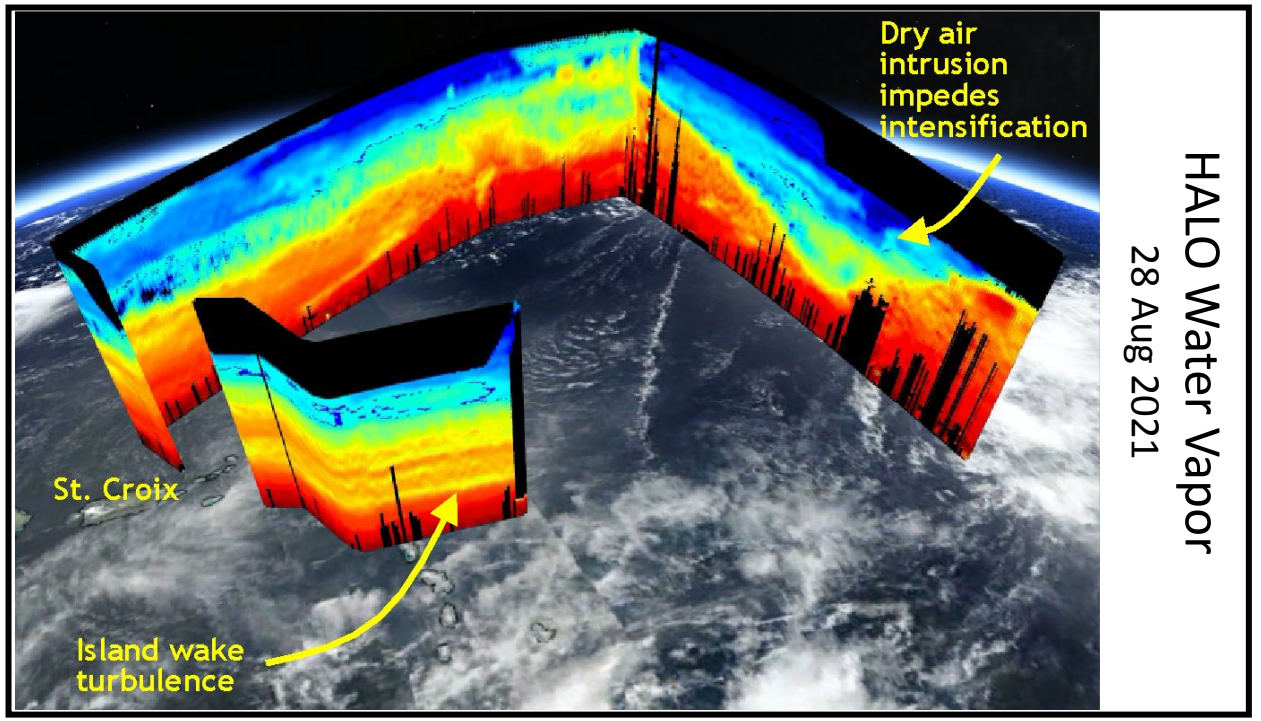
7 total DC-8 flights between 20 August and 4 September from St. Croix

- **1**: 20 Aug: **SAL (near Hurricane Henri)**, Aeolus underflight
- **2**: 21 Aug: SAL, Aeolus underflight, ITCZ, Caribbean island wakes
- **3**: 24 Aug: **Pre-Ida**, Aeolus underflight
- **4**: 26 Aug: **TS Ida**, Aeolus underflight
- **5**: 28 Aug: **TD10/Pre-Kate**, SAL, Aeolus underflight
- **6**: 1 Sept: **TS Kate,** "Aeolus underflight" (late)
- **7**: 4 Sept: **HU Larry**

Though no coordinated missions were flown, **CPEX-AW collaborated** with **ESA** and the **Joint Aeolus Tropical Atlantic Campaign (JATAC)**



DC-8 RF04 – TS Ida
26 Aug 2021



HALO Water Vapor
28 Aug 2021

2022 Convective Processes Experiment (CPEX-22) Field Campaign

Status Update

- Continuation of truncated 2021 CPEX-AW campaign
- Science traceability currently being re-assessed by the science team with the aim of *complementing and supplementing CPEX-AW objectives*
- Enhanced focus on extending the *roles of students and early career participants*
- Continue *Aeolus Cal/Val* based on the status of the satellite

- **Location: Cabo Verde**
- **NASA's DC-8 will have ~100 hours flights**
- **Timeframe: 1– 30 September**

Project Scientist: Jon Zawislak (U. of Miami/CIMAS)
Deputy Project Scientist: Ed Nowottnick (NASA/GSFC)
Lead Instrument Scientist: Amin Nehrir (NASA/LaRC)
HQ Program Managers: Hal Maring, Will McCarty, Aaron Piña

Collaborations:
ONR TCRI / MAGPIE, APHEX, JATAC (Askos); *NASA HIWC*

Expected Instruments on NASA's DC-8 Aircraft:

- **DAWN**: (Doppler Aerosol WiNd lidar)
- **HALO**: (High Altitude Lidar Observatory)
- **Dropsondes**
- **APR-3**: (Airborne Precipitation & Cloud Radar 3rd Gen.)
- **HAMSR**: (High Altitude Monolithic Microwave integrated Circuit (MMIC) Sounding Radiometer)
- **CAPS**: (Cloud Aerosol and Precipitation Spectrometer)
- **AIRO**: (Aircraft In-situ and Radio Occultation)

Not on DC-8: **Daily radiosonde launches from Cabo Verde**

CPEX-22 Field Campaign

Science Objectives* and Targets

**don't yet have the final wording*

Major scientific themes and targets organized by spatial scale of phenomena

Large-scale Environment

African Easterly Waves (AEWs)
Intertropical Convergence Zone (ITCZ)
African / SAL easterly jet (AEJ)
Saharan Air Layer (SAL)

Convective Near-environment

SAL (dry air interaction)

marine PBL (inflow/outflow, cold pools)

Aerosol - cloud interaction

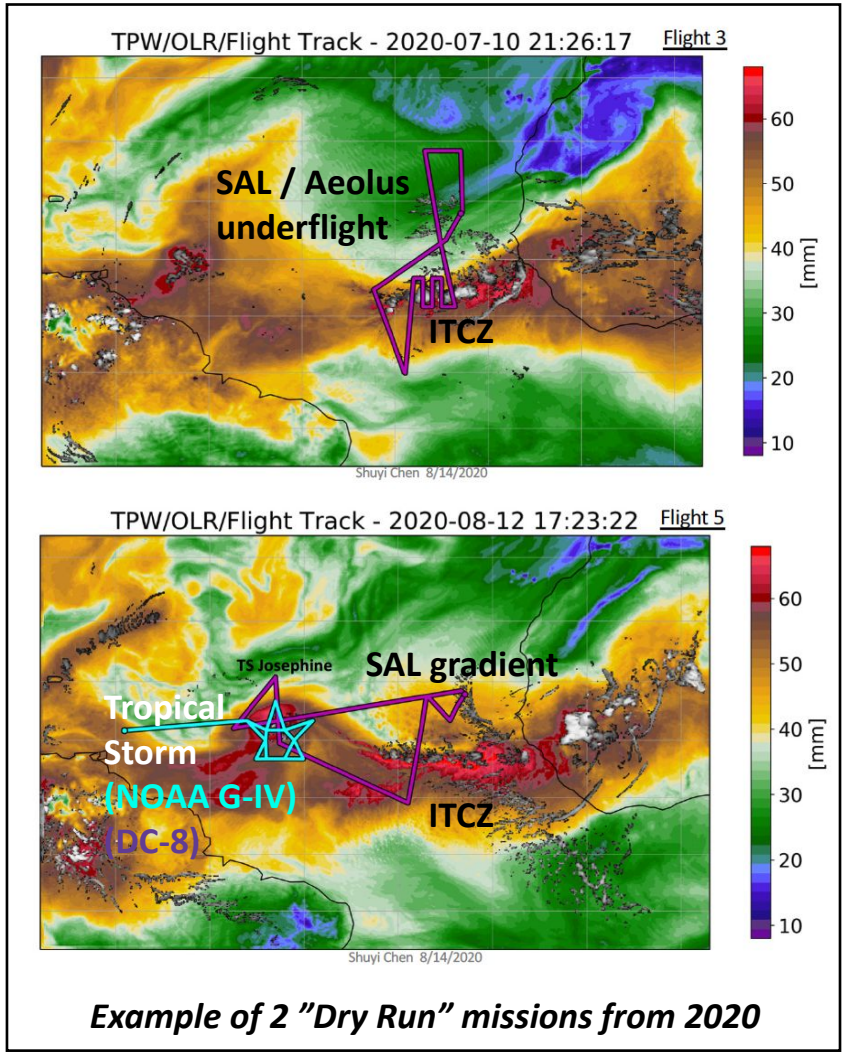
Convective Processes

Structure

Microphysics

Diurnal cycle

Initiation and lifecycle



Example of 2 "Dry Run" missions from 2020

CPEX-22 Field Campaign

What can CPEX-22 offer this group?

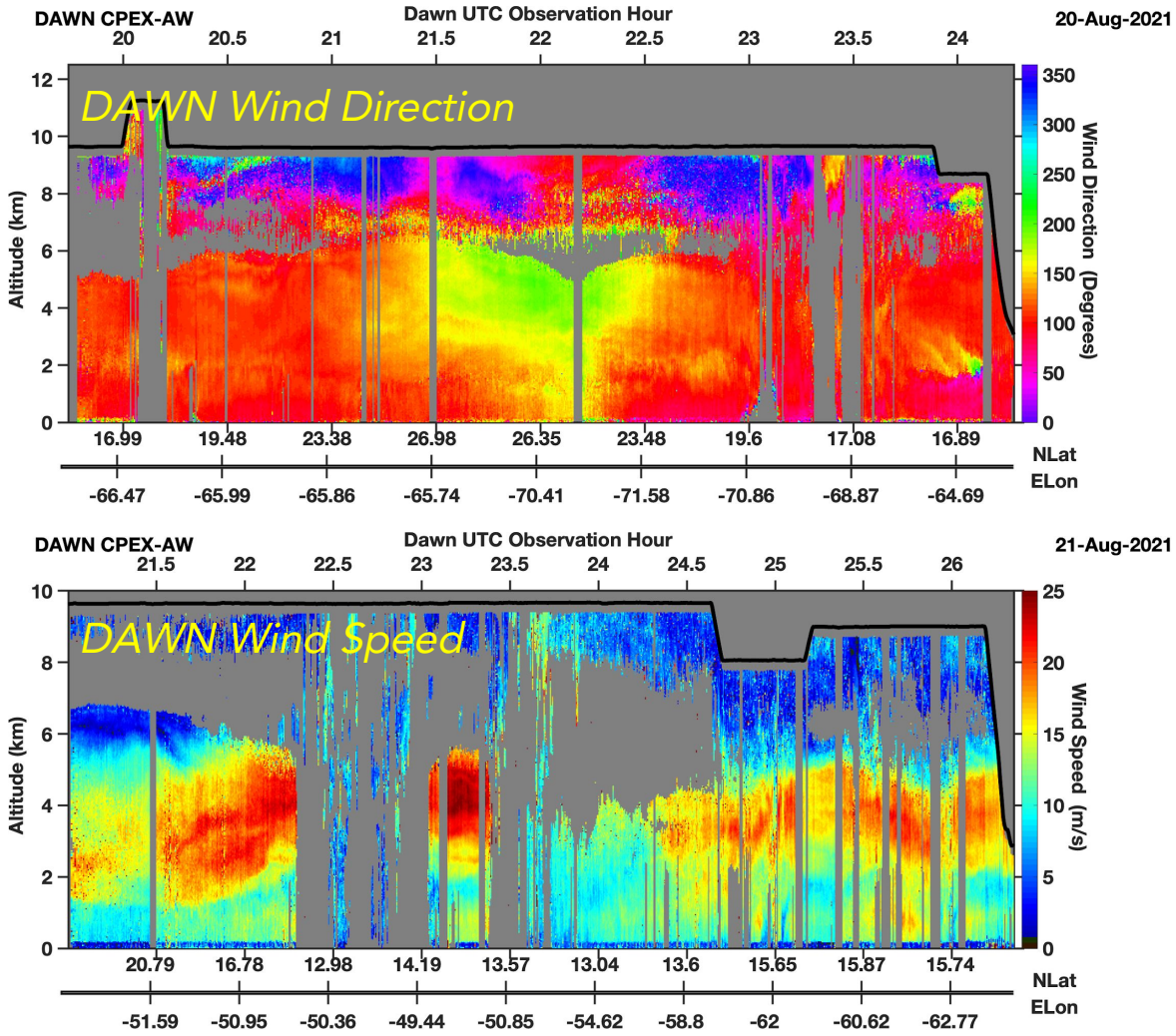
- **In addition to the scientific benefits, assess the impact of measurements on model forecasts through assimilation of those measurements**
    - We're flying in a data sparse region
    - Could include applying ensemble sensitivity targeting techniques in flight planning (ITOFS-East)
    - Prioritizing delivery of DC-8 dropsonde and Cabo Verde radiosonde data to the GTS
- **Real-time assessment of Invests and potential tropical cyclone developments**
    - Instrumentation "quick looks" are available to the CPEX-22 team, but could explore expanding that delivery to NHC
- **Collaborative science missions with NOAA aircraft**
    - Coinciding missions from Cabo Verde (DC-8 -- G-IV with ITOFS-East)
    - "Handshake" flights in the Central Atlantic (DC-8 -- NOAA P-3 and G-IV from Barbados / St. Croix)
    - NOAA flights "pick up" cases flown by DC-8 out of Cabo Verde

CPEX-22 Field Campaign

DC-8 Instrumentation and Measurables

- **DAWN**: (Doppler Aerosol WiNd lidar)

Vertical profiles of:
- Wind speed
- Wind direction

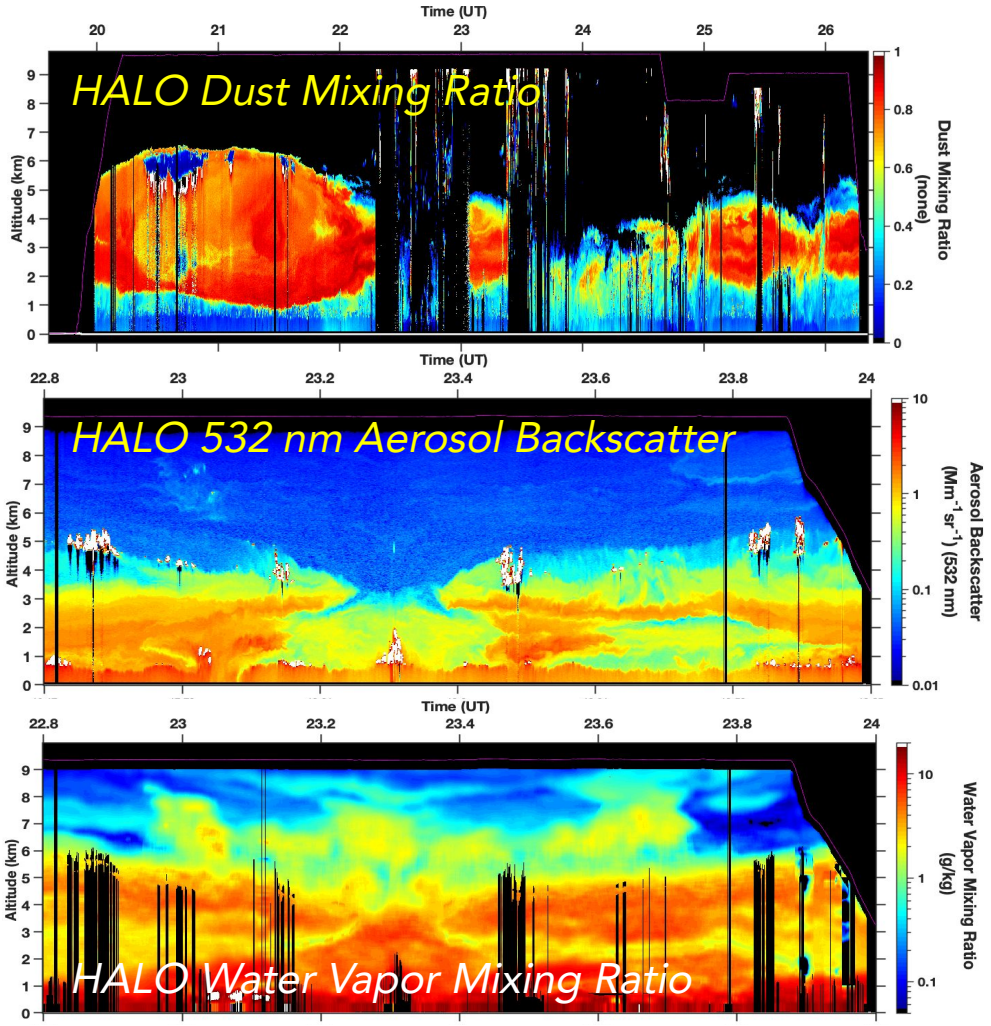


CPEX-22 Field Campaign

DC-8 Instrumentation and Measurables

- **DAWN**: (Doppler Aerosol WiNd lidar)
- **HALO**: (High Altitude Lidar Observatory)

Vertical profiles of:
- Aerosols
- Water Vapor



CPEX-22 Field Campaign

DC-8 Instrumentation and Measurables

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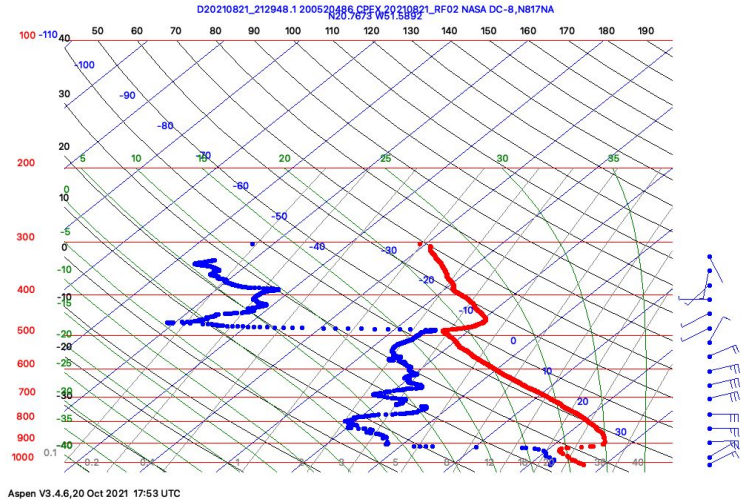
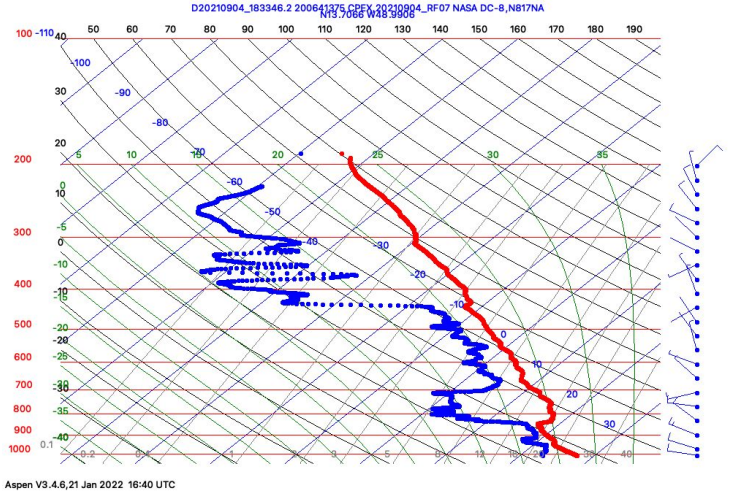
- **HALO**: (High Altitude Lidar Observatory)
- **Dropsondes**



Vertical profiles of:

- Pressure
- Temperature
- RH
- Wind



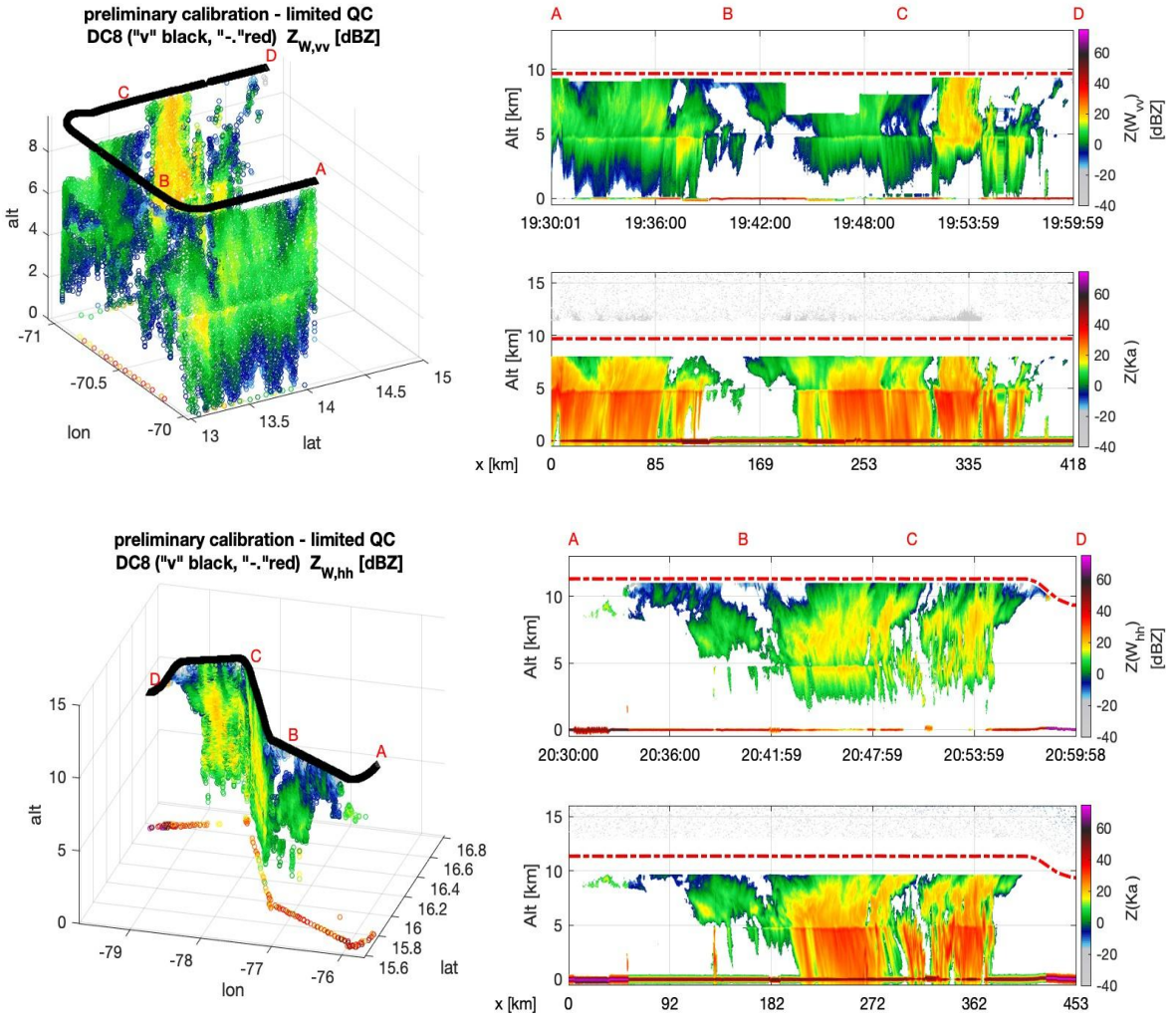
CPEX-22 Field Campaign

DC-8 Instrumentation and Measurables

- **DAWN**: (Doppler Aerosol WiNd lidar)
- **HALO**: (High Altitude Lidar Observatory)
- **Dropsondes**
- **APR-3**: (Airborne Precipitation & Cloud Radar 3rd Gen.)

Vertical profiles of:

- Ku-, Ka-, W-band reflectivity
- Microphysics
- Vertical wind



CPEX-22 Field Campaign

DC-8 Instrumentation and Measurables

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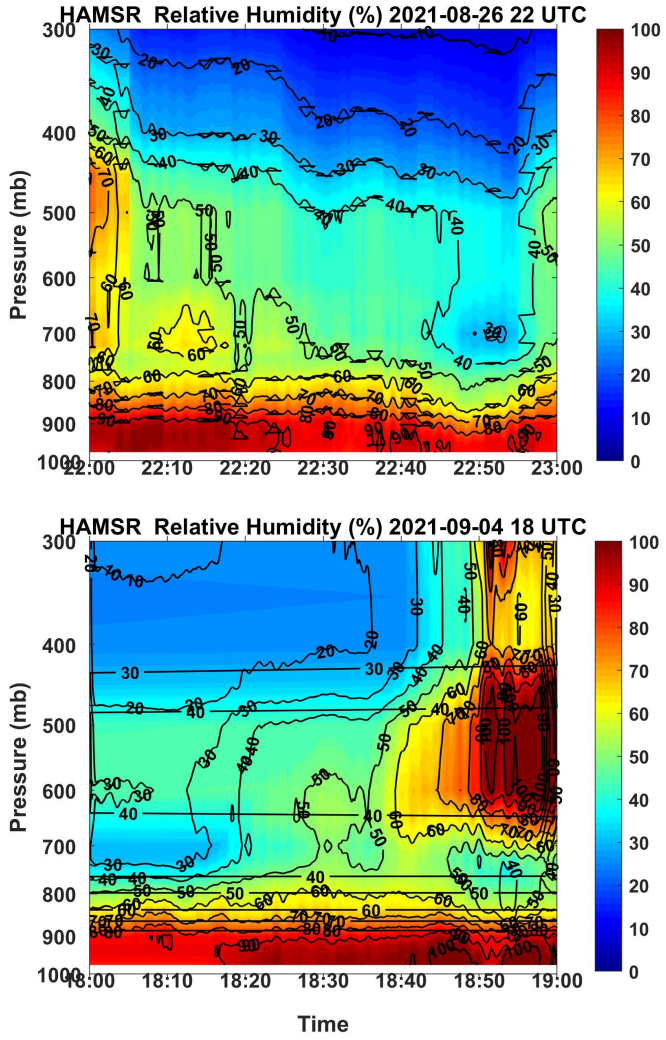
Vertical profiles and swath:

- RH / water vapor
- Temperature



CPEX-22 Field Campaign

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- **CAPS:** (Cloud Aerosol and Precipitation Spectrometer)
  - Cloud Imaging Probe (CIP), Cloud and Aerosol Spectrometer (CAS), Hotwire Liquid Water Probe
  - Cloud particles (5—1600 microns), cloud droplet and aerosol concentrations (0—0.5 microns)

CPEX-22 Field Campaign

DC-8 Instrumentation and Measurables

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- **CAPS:** (Cloud Aerosol and Precipitation Spectrometer)
- **AIRO:** (Aircraft In-situ and Radio Occultation)
  - Refractivity, temperature, water vapor profiles